

REMARKS

Initially, Applicants would like to express appreciation to the Examiner for the detailed Official Action provided, for the acknowledgment of Applicants' Claim for Priority and receipt of the certified copy of the priority document, and for the acknowledgment of Applicants' Information Disclosure Statement by return of the Form PTO-1449.

Upon entry of the above amendment, claims 1 and 13-22 will have been amended. Accordingly, claims 1-22 are currently pending. Applicants respectfully request reconsideration of the outstanding rejections and allowance of claims 1-22 in the present application. Such action is respectfully requested and is now believed to be appropriate and proper.

Claims 1-4, 6-9, 11-16, 18, 19, 21, and 22 have been rejected under 35 U.S.C. § 102(e) as being anticipated by TONG et al. (U.S. Patent No. 6,902,987).

Although Applicants do not necessarily agree with the Examiner's rejection of the claims on this ground, nevertheless, Applicants have amended independent claims 1, 13, and 22 to clearly obviate the above noted ground of rejection in order to expedite prosecution of the present application. In this regard, Applicants note that TONG et al. fails to show each and every element recited in the amended claims. In particular, claim 1, as amended, sets forth a method of bonding surfaces of two or more objects including, inter alia, "surface-treating by controlling at least one of the bonding surfaces to be bonded together so as to have a predetermined roughness in which the bonding surface has a profile including fine peaks formed at close intervals, and removing a bonding inhibitor substance from the bonding surfaces by pressing the bonding surface having fine peaks formed at close intervals against the other of the bonding surfaces so that the fine peaks shear a layer of bonding inhibitor substance from the other of the bonding surfaces, and attaching a bonding

enhancer substance on the bonding surfaces; and bonding by bringing the bonding surfaces of the two or more objects into contact with each other and bonding them”. Claim 13, as amended, sets forth an apparatus for bonding surfaces of two or more objects including, inter alia, “a surface treater that controls at least one bonding surface to have a predetermined roughness in which the bonding surface has a profile including fine peaks formed at close intervals, and removes a bonding inhibitor substance from the bonding surfaces by pressing the bonding surface having fine peaks formed at close intervals against the other of the bonding surfaces so that the fine peaks shear a layer of bonding inhibitor substance from the other of the bonding surfaces, and attaches a bonding enhancer substance on the bonding surfaces; and a bonder that contacts the bonding surfaces of the two or more objects to bond them.”. Claim 22, as amended, sets forth a method of bonding surfaces of two or more objects including, inter alia, “surface-treating by controlling at least one of the bonding surfaces to have a predetermined roughness in which the bonding surface has a profile including fine peaks formed at close intervals, and modifying the bonding surfaces by pressing the bonding surface having fine peaks formed at close intervals against the other of the bonding surfaces so that the fine peaks shear a layer of bonding inhibitor substance from the other of the bonding surfaces, on which no bonding inhibitor substances exist or from which bonding inhibitor substances have been removed, by letting bonding enhancer substances adhere under the existence of substances that adhere to the bonding surfaces in the atmosphere; and bonding by contacting the modified bonding surfaces of the two or more objects and bonding them”.

This amendment is fully supported by the specification, including the claims and drawings, and no prohibited new matter has been added.

Applicants' claimed invention provides a method of and apparatus for bonding surfaces. In particular, step S1 includes a preliminary surface treatment step to clean the bump electrodes 1b of the electronic components 1 and electrode lands 2a of the substrate 2. This initial cleaning step S1 removes oxides or adhered substances which inhibit bonding, and the metal of the bump electrodes 1b and the electrode lands 2a is exposed. Step S2 includes transporting the electronic component 1 to a surface treatment stage 4 on which the surface roughness control step is performed; and the substrate 2 is transported to a bonding stage 7. Step S3 includes a surface roughness control step in which the surface of the bump electrodes 1b is processed to have a predetermined roughness. In step S3, a rough surface plate 3 is lowered toward the bump electrodes 1b of the electronic component 1 and a predetermined pressure is applied, whereby an uneven surface profile is created on the surface of the bump electrodes 1b. In step S4, the electronic component 1 is transported to the bonding step where it is held by a bonding tool 6, so that the bump electrodes 1b and the electrode lands 2a are aligned. In step S5, ultraviolet light is projected onto the component 1 and onto the substrate 2 so as to remove bonding inhibitor substances that have adhered to the bump electrodes 1b and electrode lands 2a after the initial cleaning. In step S6, the bump electrodes 1b and the electrode lands 2a are bonded together. See particularly page 10, line 24 through page 13, line 14 of the specification; and figures 1-3.

The surface roughness control step and the subsequent bonding step are described in detail below.

Bump electrodes 1b are usually formed with a surface having a ten-point mean roughness or undulation in the order of micrometers (large roughness), and each segment of the undulation has undulation in the order of nanometers (small roughness). Figure 4 shows triangular approximations

of the large roughness and small roughness, where the peaks are denoted at $h1$ and $h2$, and the amplitude of the waves are denoted at $b1$ and $b2$, respectively. In general, the large roughness of sputtered gold (Au) film bump electrodes 1b has a peak $h1$ of a submicrometer level, while the small roughness has a peak $h2$ of about 10nm; and the large roughness of plated bump electrodes 1b has a peak $h1$ of several micrometers, while the small roughness has a peak $h2$ of about 50nm.

The initial cleaning in step S1 removes the inhibitor substances G from the metal surfaces so that they are ready to react with other substances, and metal bonding is possible if they are brought into contact with each other. See particularly figure 5A. However, the metals may fail to bond, if the inhibitor substances G that have been removed adhere on the metal again.

The present invention provides improvements and advantages over the prior art by applying an improved bonding mechanism to a mass production process. Applicants' claimed method and apparatus provides stable joints. The rough surface 3a of the rough surface plate 3 has a standardized unevenness with large roughness parameters $h1$ and $b1$. This rough surface plate 3 having a rough surface 3a formed with an uneven profile with a peak distance of b_p and a peak height of h_p as shown in Fig. 2 is pressed against the bump electrodes 1b to form unevenness on their surfaces as shown in Fig. 5C, with which a controlled number of joints E with the electrode lands 2a will be formed. By thus controlling the roughness in the surface roughness control step, it is ensured that there will be areas where the layers of re-adhered substances are sheared off, and consequently the joint strength quality is controlled in the mass production process. See particularly page 14, line 5 through page 16, line 15; and figure 5C.

Accordingly, the method and apparatus of the present invention provides bonding surfaces of two or more objects after the objects have been surface-treated, including a surface roughness control

step in which the at least one of the bonding surfaces has a predetermined roughness in which the bonding surface has a profile including fine peaks formed at close intervals. Further, the method and apparatus includes removing a bonding inhibitor substance from the bonding surfaces by pressing the bonding surface having fine peaks formed at close intervals against the other of the bonding surfaces so that the fine peaks shear a layer of bonding inhibitor substance from the other of the bonding surfaces, and attaching a bonding enhancer substance on the bonding surfaces; and bonding by bringing the bonding surfaces of the two or more objects into contact with each other and bonding them.

The TONG et al. patent discloses a bonding method including surface treating by controlling a bonding surface to have a predetermined roughness in which the surface is planarized and smoothed, removing a bonding inhibitor substance, and bonding the objects. The surface treatment step may be performed by chemical/mechanical polishing. Therefore, in the TONG et al. method, the surface roughness treatment includes polishing, planarizing, and smoothing in order to provide a smoother surface. The TONG et al. method does not include a surface roughness treatment including treating the surface in order to form peaks on the surface and make the surface less smooth. Accordingly, the TONG et al. method and apparatus do not include surface-treating by providing a bonding surface with a predetermined roughness including fine peaks formed at close intervals, and removing a bonding inhibitor substance from the bonding surfaces by pressing the fine peaks against the other of the bonding surfaces so that the fine peaks shear a layer of bonding inhibitor substance from the other bonding surface.

Thus, the TONG et al. patent does not show a bonding method including, inter alia, "surface-treating by controlling at least one of the bonding surfaces to be bonded together so as to have a

predetermined roughness in which the bonding surface has a profile including fine peaks formed at close intervals, and removing a bonding inhibitor substance from the bonding surfaces by pressing the bonding surface having fine peaks formed at close intervals against the other of the bonding surfaces so that the fine peaks shear a layer of bonding inhibitor substance from the other of the bonding surfaces, and attaching a bonding enhancer substance on the bonding surfaces; and bonding by bringing the bonding surfaces of the two or more objects into contact with each other and bonding them”, as set forth in amended claim 1. Further, TONG et al. fails to disclose a bonding apparatus including, inter alia, “a surface treater that controls at least one bonding surface to have a predetermined roughness in which the bonding surface has a profile including fine peaks formed at close intervals, and removes a bonding inhibitor substance from the bonding surfaces by pressing the bonding surface having fine peaks formed at close intervals against the other of the bonding surfaces so that the fine peaks shear a layer of bonding inhibitor substance from the other of the bonding surfaces, and attaches a bonding enhancer substance on the bonding surfaces; and a bonder that contacts the bonding surfaces of the two or more objects to bond them.”, as set forth in amended claim 13. TONG et al. fails to disclose a bonding method including, inter alia, “surface-treating by controlling at least one of the bonding surfaces to have a predetermined roughness in which the bonding surface has a profile including fine peaks formed at close intervals, and modifying the bonding surfaces by pressing the bonding surface having fine peaks formed at close intervals against the other of the bonding surfaces so that the fine peaks shear a layer of bonding inhibitor substance from the other of the bonding surfaces, on which no bonding inhibitor substances exist or from which bonding inhibitor substances have been removed, by letting bonding enhancer substances adhere under the existence of substances that adhere to the bonding surfaces in the atmosphere; and

bonding by contacting the modified bonding surfaces of the two or more objects and bonding them”, as set forth in amended claim 22. Since the reference fails to show each and every element of the claimed device, the rejection of claims 1, 13, and 22 under 35 U.S.C. § 102(b) over TONG et al. is improper and withdrawal thereof is respectfully requested.

Applicants submit that dependent claims 2-4, 6-9, 11, 12, 18, 19, and 21, which are at least patentable due to their dependency from claims 1 and 13 for the reasons noted above, recite additional features of the invention and are also separately patentable over the prior art of record based on the additionally recited features.

Claims 5 and 17 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over TONG et al. in view of HORI et al. (U.S. Patent Appl. Pub. No. 2004/0105155).

Applicants note that TONG et al. fails to teach or suggest the subject matter claimed as set forth in independent claims 1 and 13, as described above. Further, HORI et al. fails to cure these deficiencies. In this regard, while HORI et al. teaches the use of a tool to provide an uneven surface profile, HORI et al. still fails to teach or suggest surface-treating by providing a bonding surface with a predetermined roughness including fine peaks formed at close intervals, and removing a bonding inhibitor substance from the bonding surfaces by pressing the fine peaks against the other of the bonding surfaces so that the fine peaks shear a layer of bonding inhibitor substance from the other bonding surface. Thus, for at least these reasons, even if the teachings of TONG et al. and HORI et al. were combined, as suggested by the Examiner, the claimed combination would not result. Moreover, there is nothing in the cited prior art that would lead one of ordinary skill in the art to make the modification suggested by the Examiner in the rejection of claims 5 and 17 under 35 U.S.C. § 103(a) over TONG et al. in view of HORI et al. Thus, the only reason to combine the

teachings of TONG et al. and HORI et al. results from a review of Applicants' disclosure and the application of impermissible hindsight. Accordingly, the rejection of claims 5 and 17 under 35 U.S.C. § 103(a) over TONG et al. in view of HORI et al. is improper for all the above reasons and withdrawal thereof is respectfully requested.

Claims 10 and 20 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over TONG et al. in view of KUB et al. (U.S. Patent No. 6,153,495).

Applicants note that TONG et al. fails to teach or suggest the subject matter claimed as set forth in independent claims 1 and 13, as described above. Further, KUB et al. fails to cure these deficiencies. In this regard, while KUB et al. teaches the use of ultraviolet irradiation for surface treatment, KUB et al. still fails to teach or suggest surface-treating by providing a bonding surface with a predetermined roughness including fine peaks formed at close intervals, and removing a bonding inhibitor substance from the bonding surfaces by pressing the fine peaks against the other of the bonding surfaces so that the fine peaks shear a layer of bonding inhibitor substance from the other bonding surface. Thus, for at least these reasons, even if the teachings of TONG et al. and KUB et al. were combined, as suggested by the Examiner, the claimed combination would not result.

Moreover, there is nothing in the cited prior art that would lead one of ordinary skill in the art to make the modification suggested by the Examiner in the rejection of claims 10 and 20 under 35 U.S.C. § 103(a) over TONG et al. in view of KUB et al. Thus, the only reason to combine the teachings of TONG et al. and KUB et al. results from a review of Applicants' disclosure and the application of impermissible hindsight. Accordingly, the rejection of claims 10 and 20 under 35 U.S.C. § 103(a) over TONG et al. in view of KUB et al. is improper for all the above reasons and withdrawal thereof is respectfully requested.

Accordingly, Applicants respectfully request reconsideration and withdrawal of the rejections, and an early indication of the allowance of claims 1-22.

SUMMARY AND CONCLUSION

In view of the foregoing, it is submitted that the present amendment is proper and that none of the references of record, considered alone or in any proper combination thereof, anticipate or render obvious Applicants' invention as recited in claims 1-22. The applied references of record have been discussed and distinguished, while significant claimed features of the present invention have been pointed out.

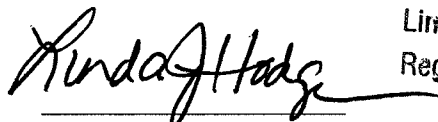
Accordingly, consideration of the present amendment, reconsideration of the outstanding Official Action, and allowance of the present amendment and all of the claims therein are respectfully requested and now believed to be appropriate.

Applicants have made a sincere effort to place the present application in condition for allowance and believe that they have now done so.

Any amendments to the claims which have been made in this amendment, which do not narrow the scope of the claims, and which have not been specifically noted to overcome a rejection based upon the prior art, should be considered cosmetic in nature, and to have been made for a purpose unrelated to patentability, and no estoppel should be deemed to attach thereto.

Should the Examiner have any questions, the Examiner is invited to contact the undersigned
at the below-listed telephone number.

Respectfully submitted,
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